Outline

- Background and objectives
- Nozzle overview and ground test results
- Flight test approach and pilot-vehicle interface
- Flight test execution and results
- Concluding remarks

I'd like to present the background and objectives of the program.....

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Thrust Vectoring Usage in U.S. Fighter Aircraft

AV-8B Harrier II

F-15 STOL / Maneuvering Technology Demonstrator

Thrust vectoring technology has been successfully demonstrated on several previous programs to provide tactical maneuvering advantages in the slow speed, high aoa flight regime. For many years, the AV-8B has employed thrust vectoring to win air combat engagements against unsuspecting conventional aircraft.

The STOL and Maneuvering Technology Demonstrator used pitch-only vectoring for enhanced agility throughout the flight envelope, and when combined with thrust reversing, was able to make very short landings.

Thrust Vectoring Usage in U.S. Fighter Aircraft

These three pictured aircraft all use both pitch and yaw vectoring:

The F-18 HARV, or High Angle of Attack Research Vehicle and the X-31 both used pitch and yaw thrust vectoring paddles to explore maneuvering at angles of attack up to 70 degrees and performed a tactical utility evaluations.

The F-16 MATV, which stands for Multi-Axis Thrust Vectoring, used, axisymmetric, thrust vectoring during 1v1 and 2v1 engagements at unlimited angles of attack.

Thrust Vectoring Usage in U.S. Fighter Aircraft

YF-22

MDA / NGC / BAE JSF

The YF-22 used pitch-only thrust vectoring to provide enhanced pitch maneuvering. Both the production F-22 and this proposed Joint Strike Fighter aircraft will employ some form of thrust vectoring to enhance maneuverability.

Almost all of the thrust vectoring explored to date has been concentrated in the low speed, high alpha flight regime. The overall goal of the ACTIVE F-15 test program, however, is to expand the vectoring flight envelope to MACH 2, and to determine its utility to enhance performance and controllability. Such technology will be key for hyper-modern tailless fighter designs.

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Program Objectives

- Nozzle flight envelope expansion
- Nozzle performance
- Aircraft performance
- Adaptive Aircraft Performance Technology
- Envelope: 7.3 g; Mach 2.0; 1,600 psf; 30^{o} AOA

The ACTIVE flight test program contains four main objectives.

- Nozzle envelope expansion
- Nozzle-induced effects
- Performance testing with and without vectoring.
- Adaptive Performance Technology, optimizes the performance of the complete aircraft and vectoring system in real time, using a generic, adaptive, measurement-based algorithm.

Flight envelope goals are Mach 2, 1,600 psf dynamic pressure, and 30 degrees angle of attack, which will allow adequate capability to meet the research requirements.

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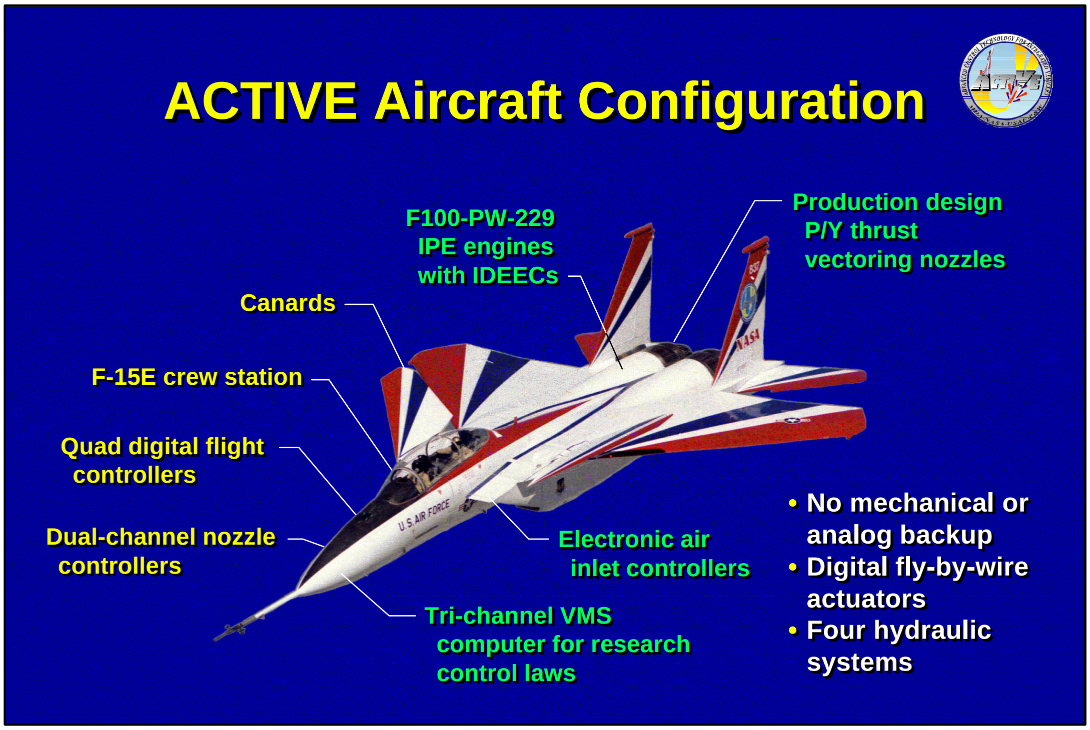
F-15 ACTIVE Research Aircraft

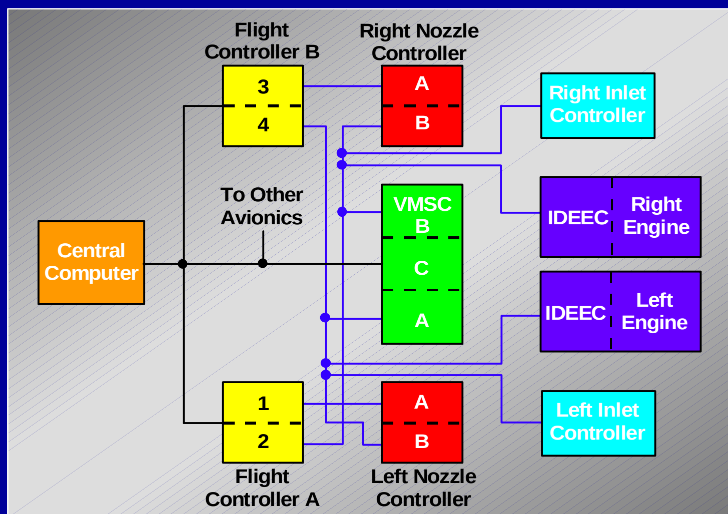
The test aircraft, NASA 837, was preproduction F-15B number 1. The aircraft previously was used as the STOL and Maneuvering Technology Demonstrator and is highly modified.



This aircraft was selected to serve as the research testbed because of the flexibility of its unique quadruplex, fly-by-wire, flight and propulsion control system. No mechanical control links remain, not even between the throttle and the engines.

The ACTIVE aircraft is equipped with an F-15E-style glass cockpit, mega-thrust Dash 229 engines with pitch and yaw vectoring, canards and a flight test nose boom with alpha and beta vanes, and a temperature probe. Structural modifications were necessary to accommodate vectoring forces of the nozzles which are limited by software to 4,000 lb per engine in any direction.

ACTIVE Avionics Architecture



The quadruplex flight and propulsion control system was retained but was augmented with a Vehicle Management System. This powerful computer performs computational intensive functions such as performance optimization or neural network operations. In addition, it integrated 9 other computers into the system, the 2 inlet controllers, 2 IDEEC engine controllers, 2 flight control computers, 2 nozzle computers, and the aircraft's central computer. This architecture allows the VMS to schedule the pitch and yaw vectoring, to trim the surfaces, to modify the scheduling of the air inlets, and modify the operation of the engines, integrating all for maximum performance.